Azimuthal asymmetry of J/ψ suppression in non-central heavy-ion collisions *

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In the search for quark-gluon plasma (QGP), J/ψ suppression has been proposed as one of the promising signals of the deconfinement in high-energy heavy-ion collisions. Because of the color screening effect in a quark-gluon plasma, the linear confining potential in vacuum that binds two heavy quarks to form a quarkonium disappears so that it can be easily broken up causing suppression of the J/ψ production. The problem in heavy-ion collisions is however complicated by other competing mechanisms such as initial nuclear absorption [**?**] and hadronic dissociation. While recent precision data from the NA50 experiment at the CERN SPS energies clearly show anomalous suppression unexplained by the normal initial nuclear absorption, there are still much debates about the exact nature of the anomalous suppression, whether it is caused by the formation of QGP or dissociation by ordinary hadronic matter.

We propose in this letter the study of azimuthal asymmetry of J/ψ production as additional measurements to distinguish different competing mechanism of J/ψ suppression. Since the initial state interactions such as nuclear absorption or nuclear shadowing of gluon distribution has no preference over the azimuthal direction they will not have any contribution to the azimuthal anisotropy of the J/ψ production. Only suppression by the final state interaction with the produced medium will cause significant azimuthal anisotropy in the final J/ψ distribution in the transverse direction. If the centrality dependence of the J/ψ suppression additional to the initial nuclear absorption is caused by formation of QGP, it must be accompanied by a sudden onset of the azimuthal anisotropy. On the other hand, a hadronic absorption scenario would give a continuous centrality dependence of the azimuthal anisotropy. In this letter, we will study the centrality dependence of both the averaged J/ψ suppression factor and the azimuthal anisotropy with a model in which J/ψ suppression is caused by initial nuclear absorption and final state dissociation by QGP above a critical density. Using parameters from fitting the NA50 data, we will also give predictions for J/ψ suppression and its azimuthal anisotropy at the RHIC energies.

We follow the microdynamic approach of J/ψ suppression, in which the J/ψ suppression is caused by gluonic dissociation. The gluonic dissociation cross section in this model depends strongly on the gluon density and the averaged energy of the gluons in the medium. In a hadron gas, one finds the effective hadron-J/ψ cross section to be extremely small because of the small gluon distribution inside a thermal hadron. Furthermore, average energy carried by the gluon inside a thermal hadron is much smaller than the threshold energy of J/ψ dissociation. This further suppresses hadron-J/ψ dissociation cross section. We should emphasize that such an assumption is model dependent. Results of other theoretical calculations of hadron-J/ψ dissociation also vary widely, generally potential models giving large cross sections while effective interaction models giving much smaller values. For consistency we will assume a small hadron-J/ψ cross section within the gluon dissociation model. Therefore, we can neglect the J/ψ dissociation in a hadron gas which exist in the peripheral heavy-ion collisions and the late stage of central collisions.

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